Considerations from the past for the future of mineral carbonation

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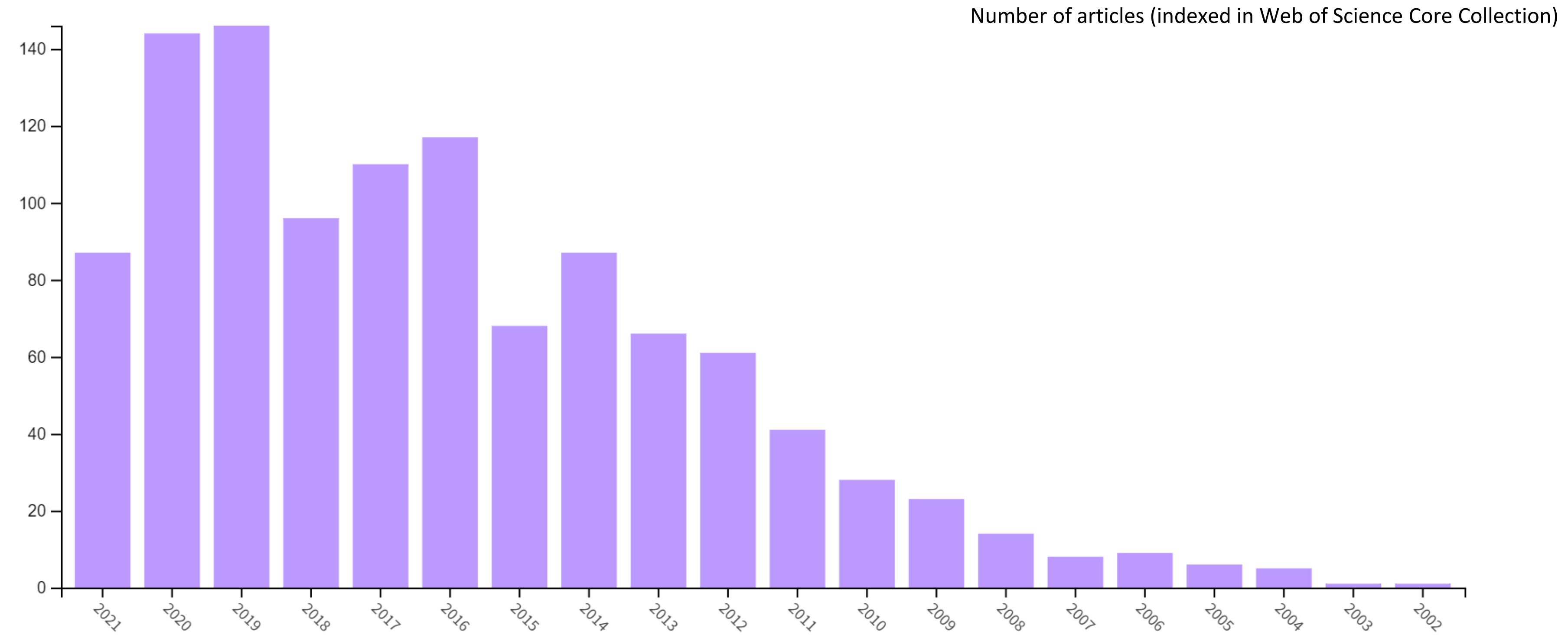
ARPA- E Workshop: SCHEMA (Sequestering Carbon with Hybrid Employment of Mineral Assets)
July 15th 2021

Bibliometric Trends (1)

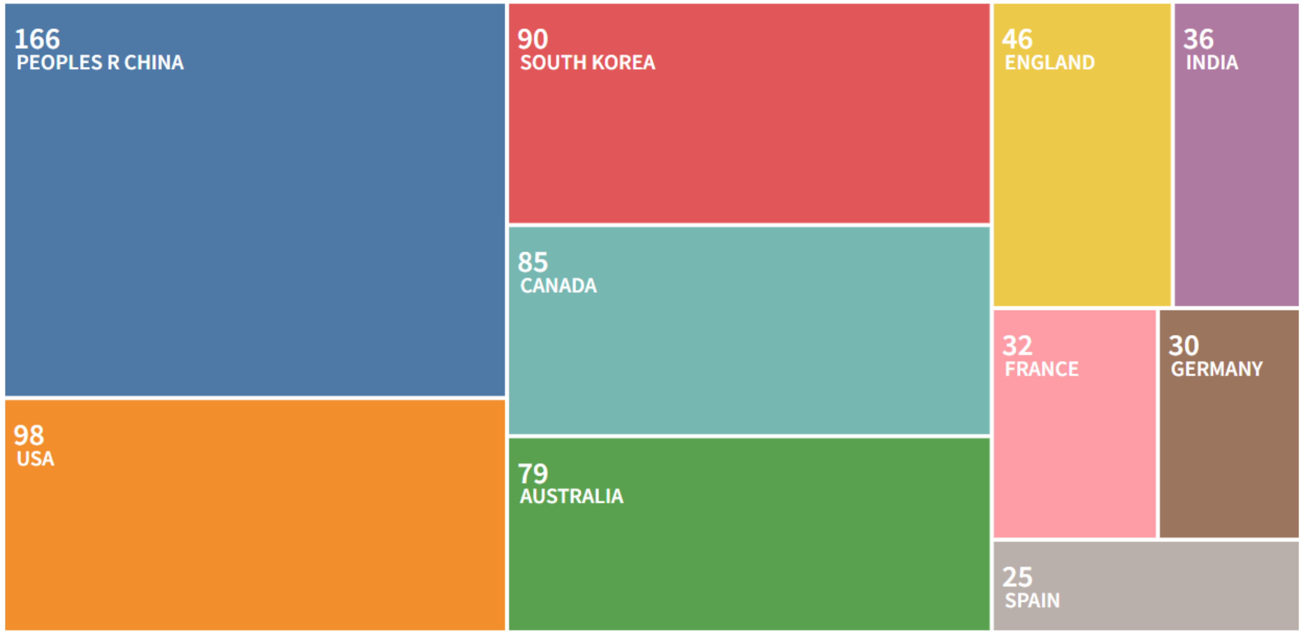


TOPIC: ("mineral carbonation" OR "CO2 minerali*" OR "mineral carbon sequestration")

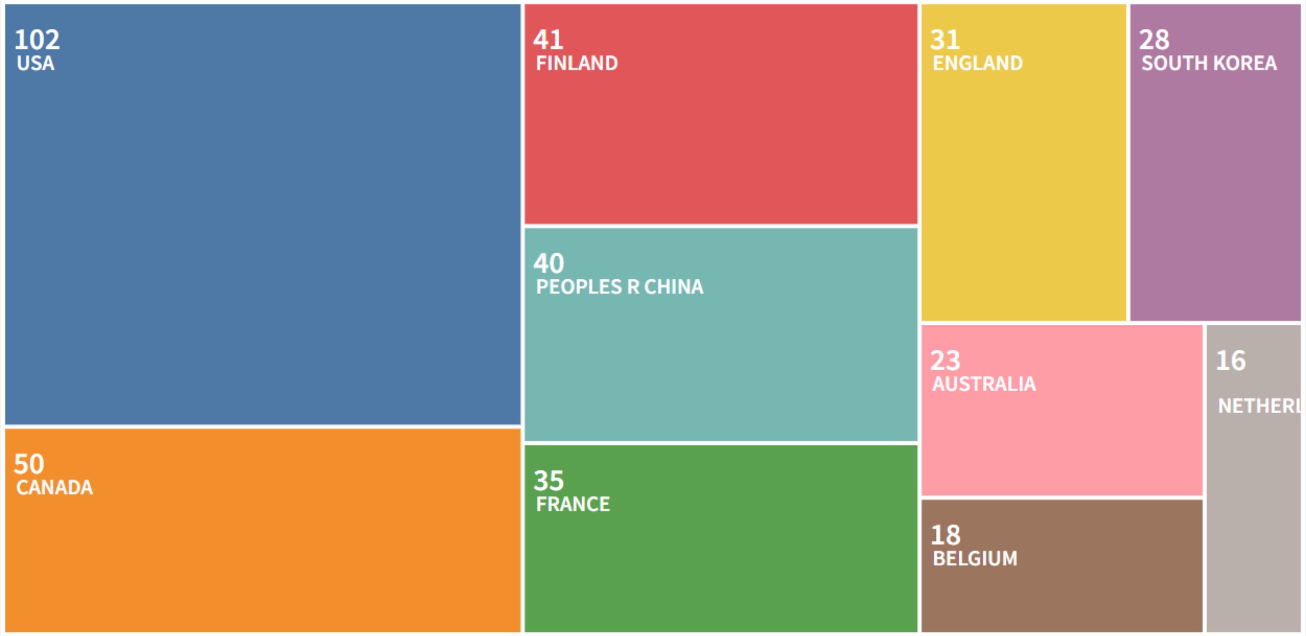
Bibliometric Trends (2)

TOPIC: ("mineral carbonation" OR "CO2 minerali*" OR "mineral carbon sequestration")

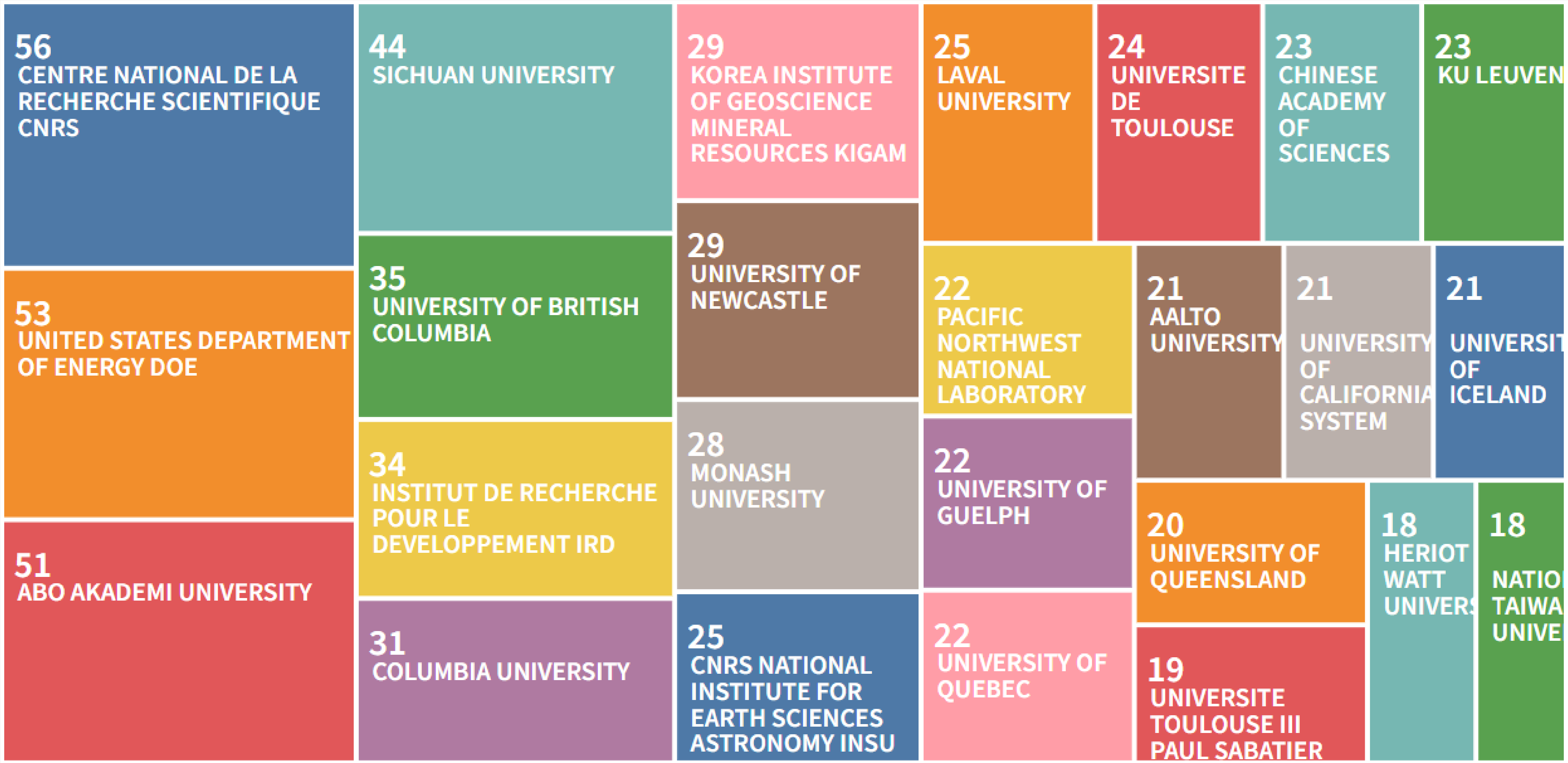
2016-2021:



2002-2015:



Bibliometric Trends (3)



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Periodic Table of Carbonates

H_2CO_3																	He
Li_2CO_3	$BeCO_3$											B	C	N	O	F	Ne
Na_2CO_3	$MgCO_3$											$Al_2(CO_3)_3$	Si	P	S	Cl	Ar
K_2CO_3	$CaCO_3$	Sc	Ti	V	Cr	$MnCO_3$	$FeCO_3$	$CoCO_3$	$NiCO_3$	$CuCO_3$	$ZnCO_3$	Ga	Ge	As	Se	Br	Kr
Rb_2CO_3	$SrCO_3$	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag_2CO_3	$CdCO_3$	In	Sn	Sb	Te	I	Xe
Cs_2CO_3	$BaCO_3$		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl_2CO_3	$PbCO_3$	Bi	Po	At	Rn
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Uut	Uuq	Uup	Uuh	Uus	Uuo

↓

$La_2(CO_3)_3$	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

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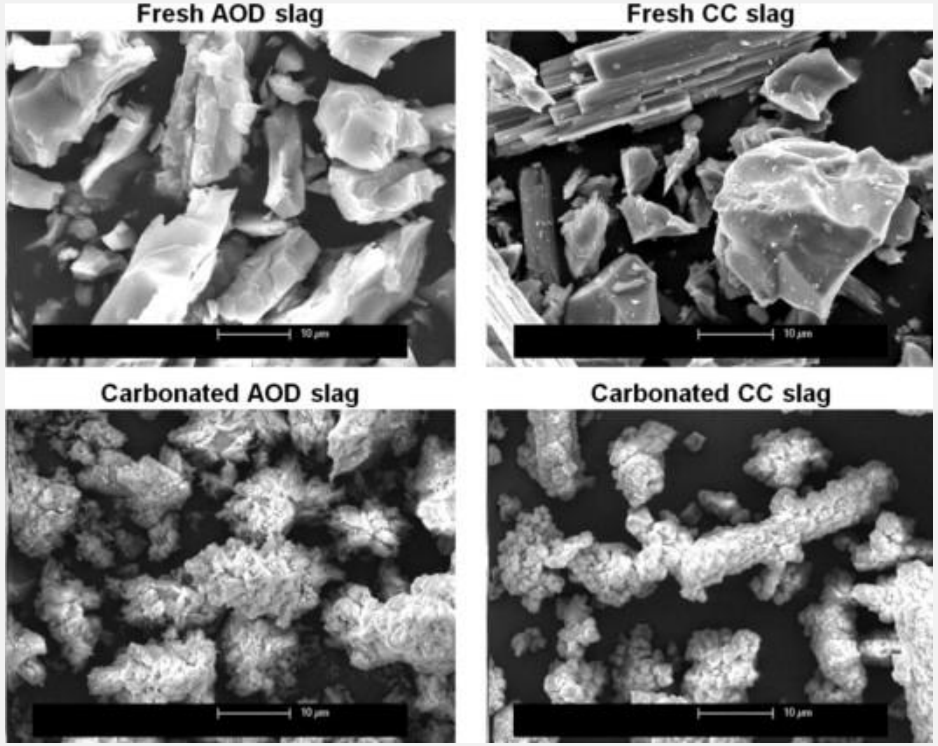
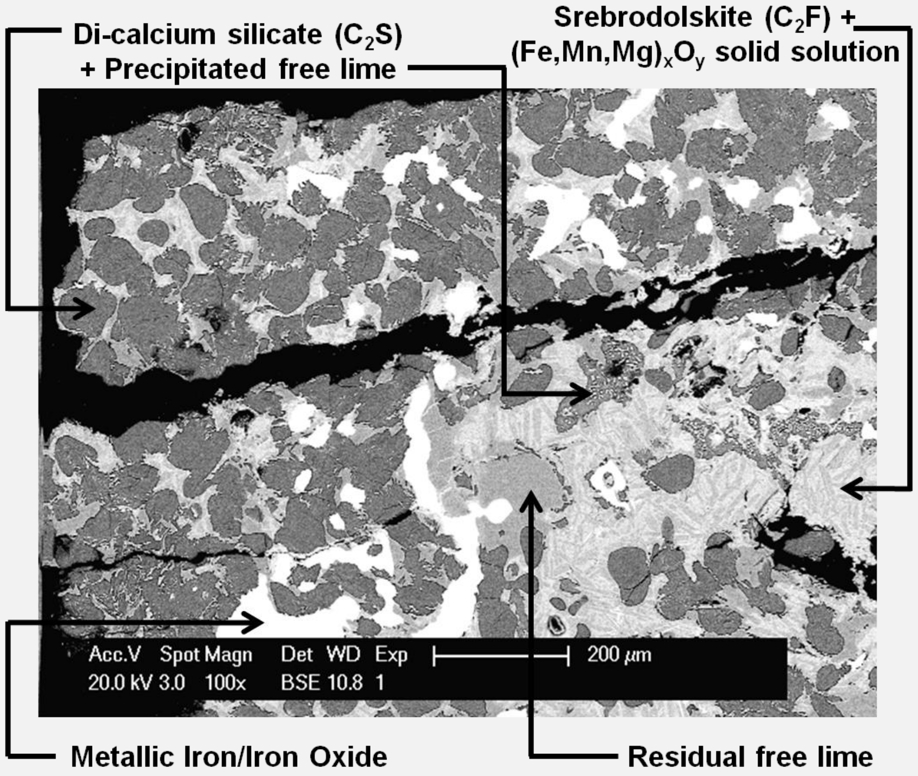
Particle exterior versus interior (1)

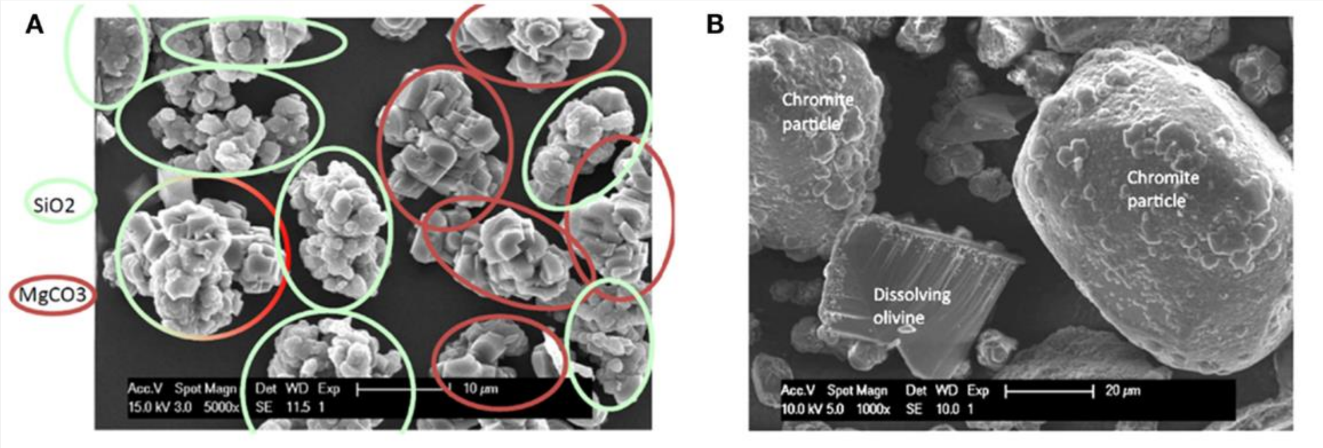


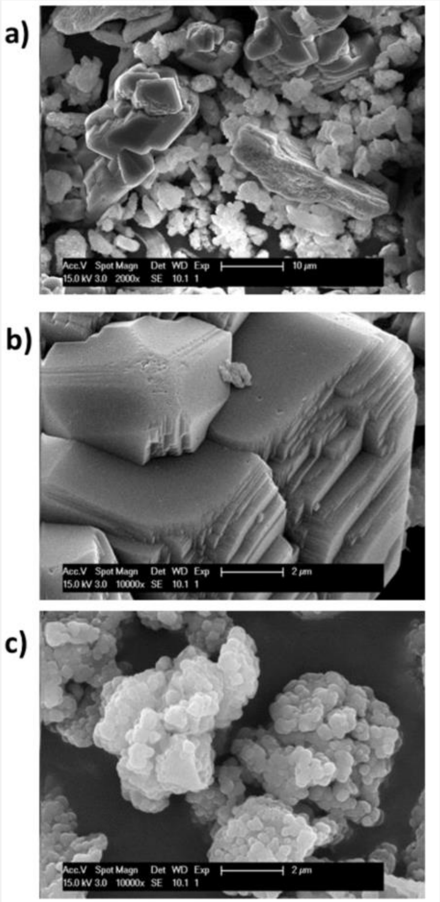


Stabilization of basic oxygen furnace slag by hot-stage carbonation treatment. [Chemical Engineering Journal, (2012), 203, 239-250].

Accelerated mineral carbonation of stainless steel slags for CO_2 storage and waste valorization: effect of process parameters on geochemical properties. [International Journal of Greenhouse Gas Control, (2013), 17, 32-45].

Particle exterior versus interior (2)





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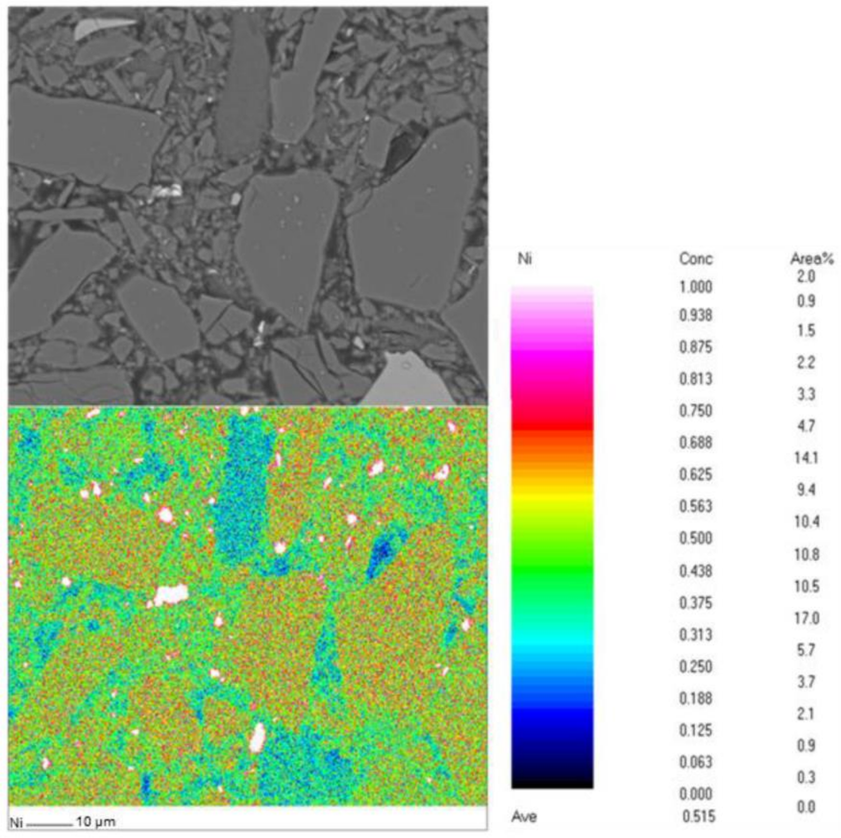
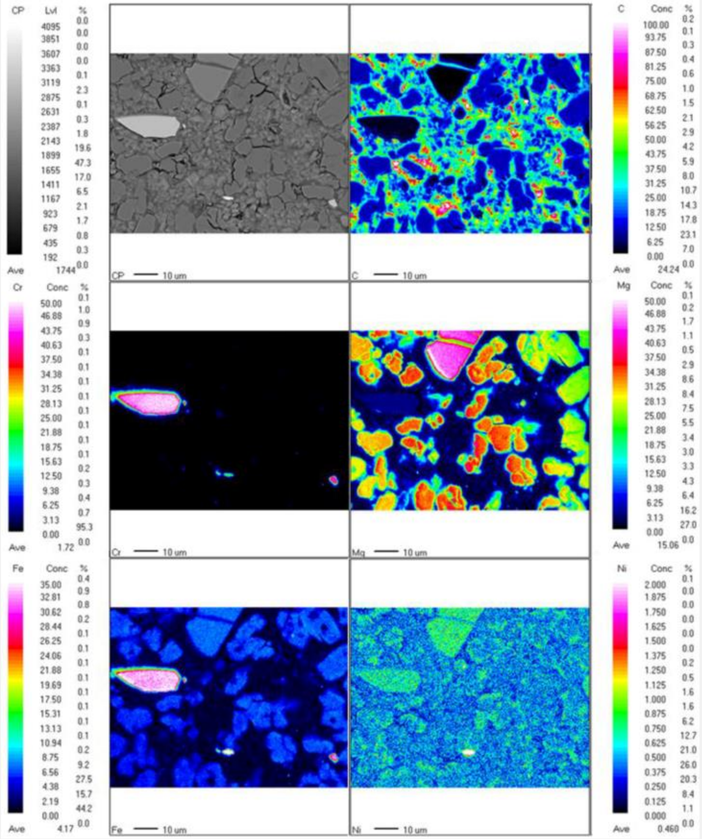
CO_2 Energy Reactor – Integrated Mineral Carbonation: Perspectives on Lab-Scale Investigation and Products Valorization. Frontiers in Energy Research, (2016), 4, 5.

Nickel Extraction from Olivine: Effect of Carbonation Pre-Treatment. Metals, (2015), 5(3), 1620-1640.

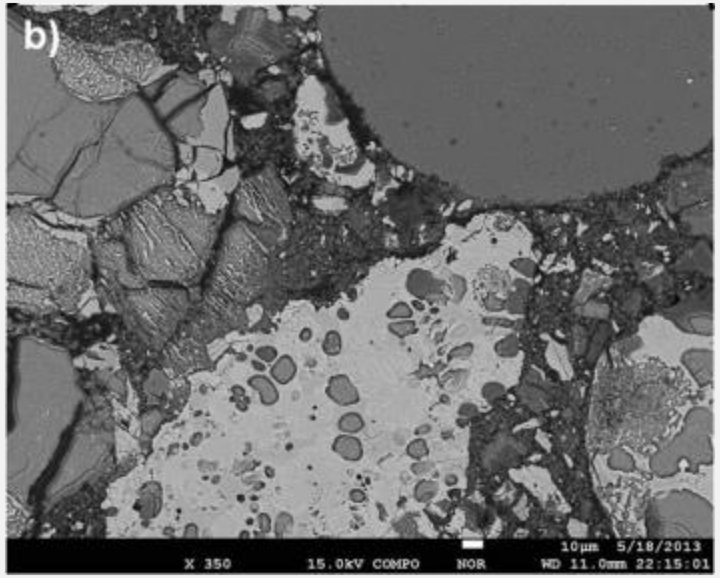
Particle exterior versus interior (3)

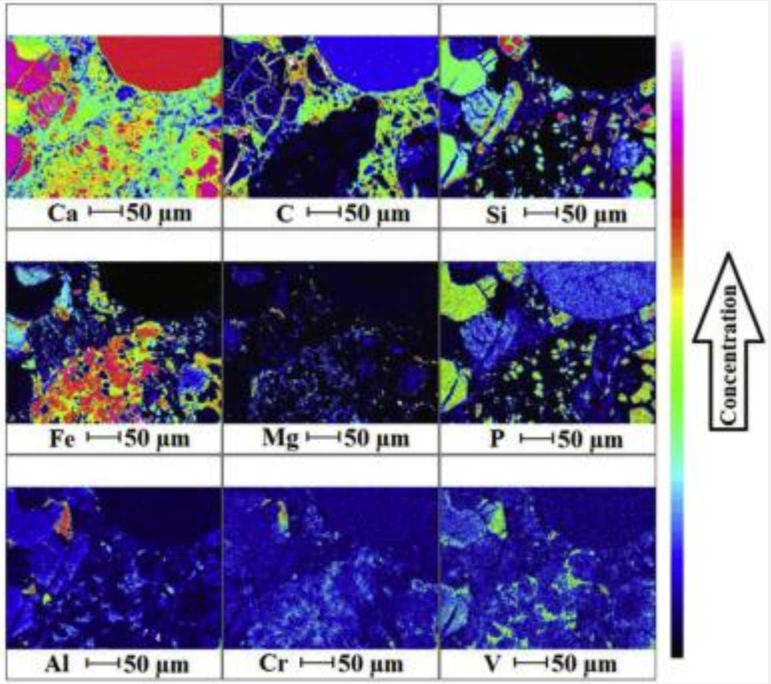


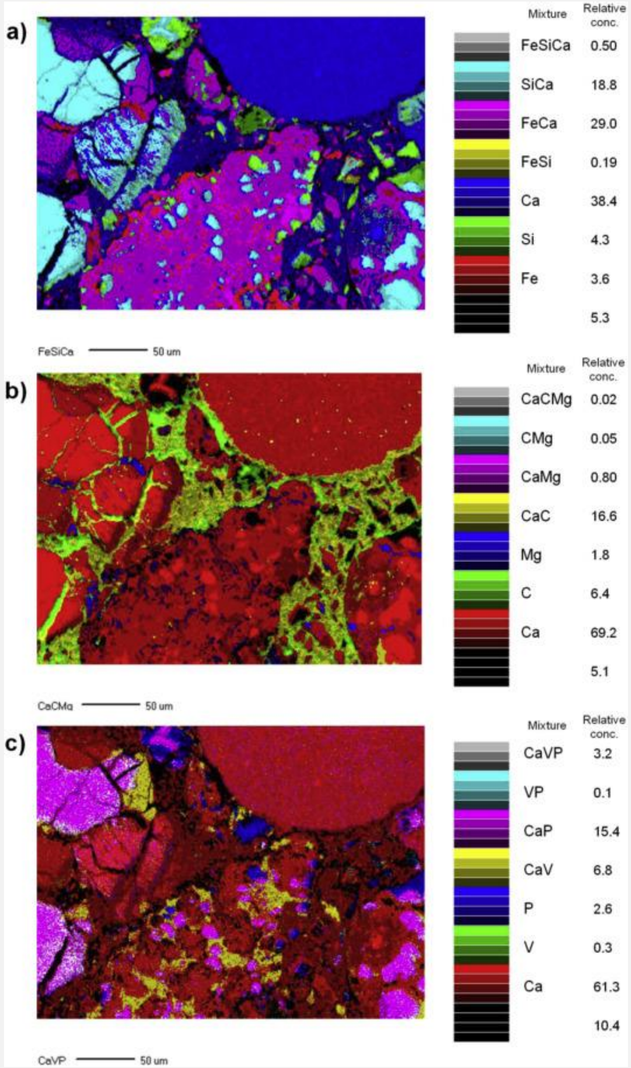


Nickel Extraction from Olivine: Effect of Carbonation Pre-Treatment.
Metals, (2015), 5(3), 1620-1640.

Particle exterior versus interior (4)







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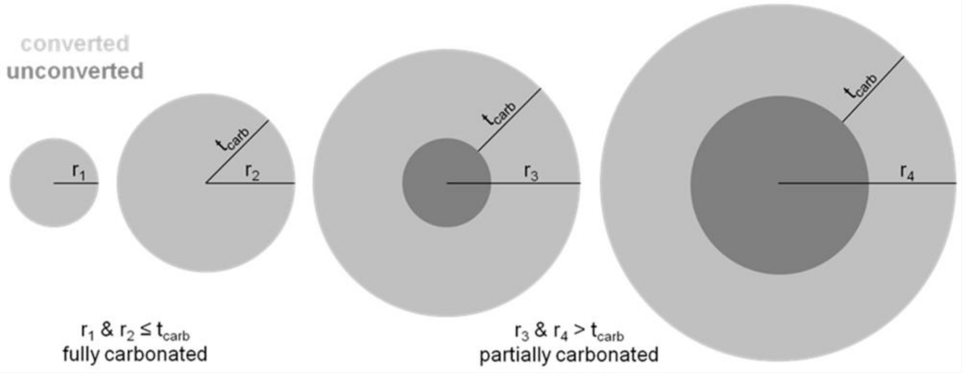
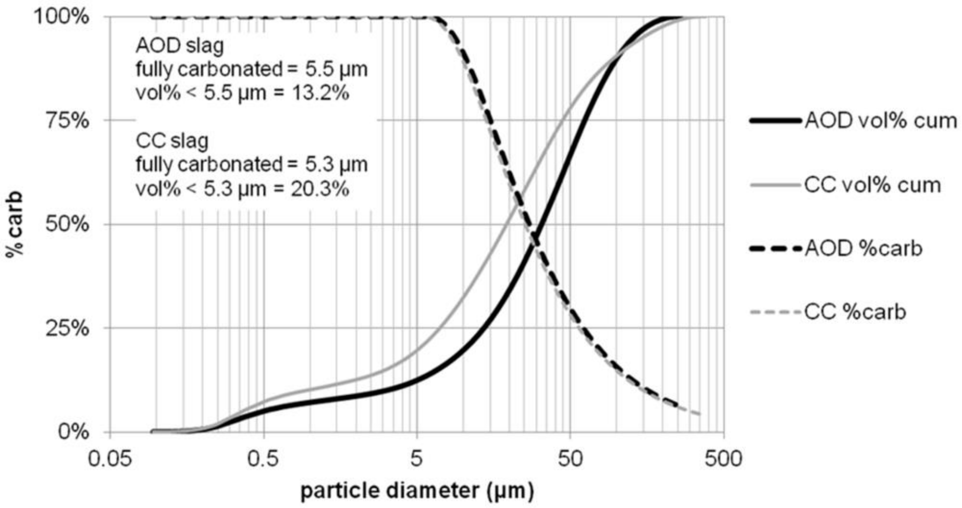
Laboratory investigation of carbonated BOF slag used as partial replacement of natural aggregate in cement mortars. [Cement and Concrete Composites, (2016), 65, 55-66].

Particle Size vs. Particle Size Distribution

$$CWR = \frac{t_{carb}}{\tau_{react}} = \frac{r_x \cdot \left(1 - \sqrt[3]{1 - C\%/100\%}\right)}{\tau_{react}}$$

$$\%carb = \begin{cases} if\,[r_x \le t_{carb}]\,, = 100\% \\ if\,[r_x > t_{carb}]\,, = \dfrac{\frac{4}{3}\pi r_x^3 - \frac{4}{3}\pi (r_x - t_{carb})^3}{\frac{4}{3}\pi r_x^3} \end{cases}$$





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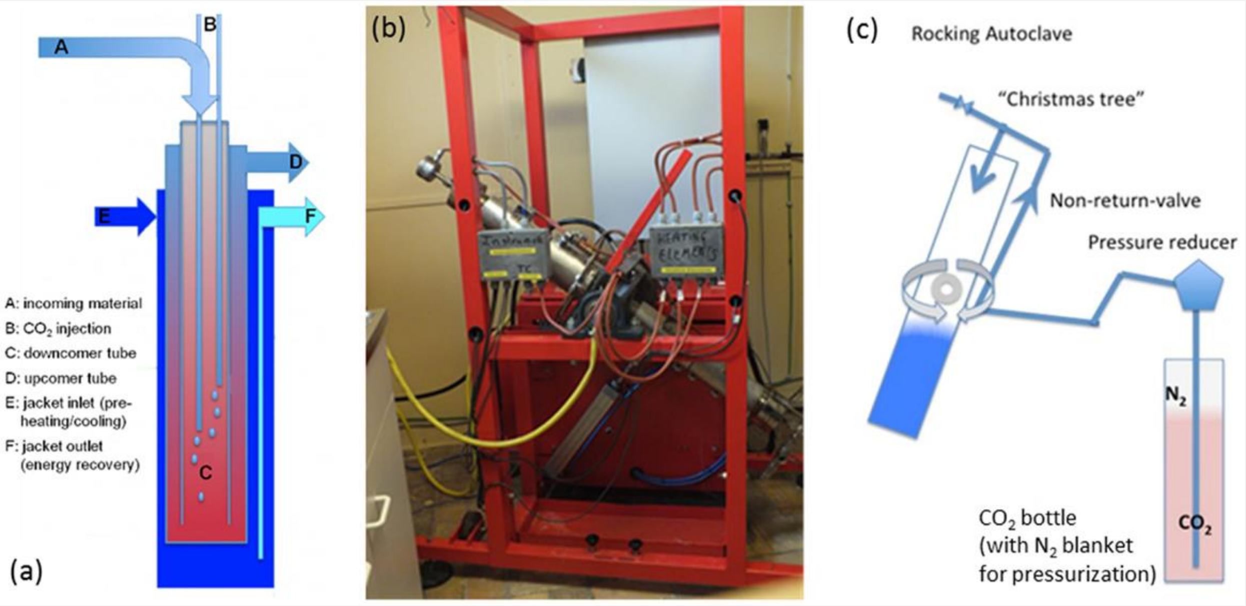
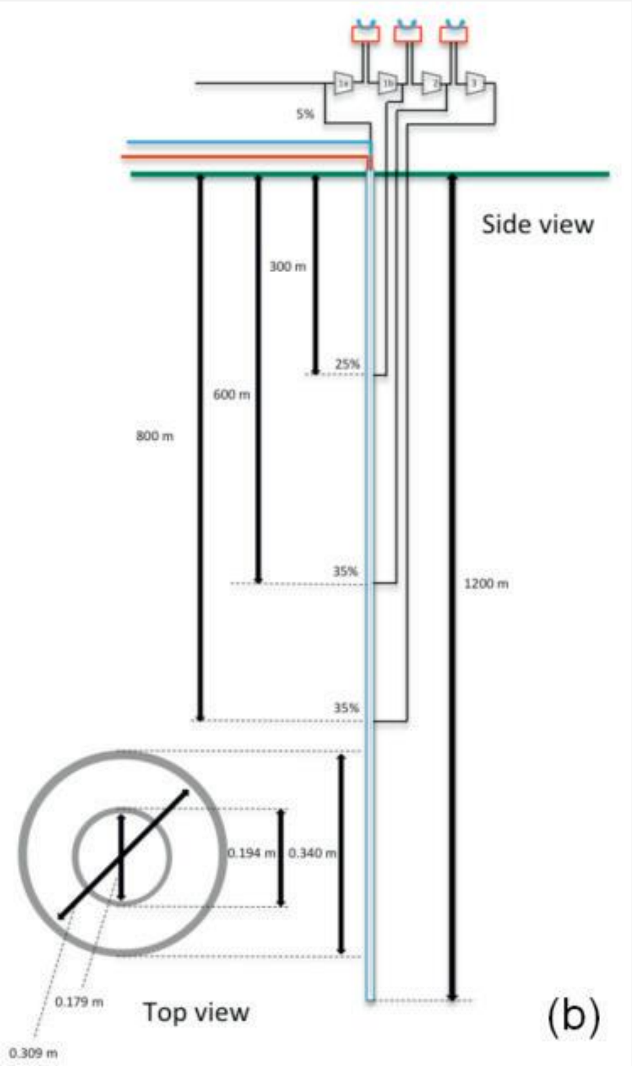
How characterization of particle size distribution pre- and post-reaction provides mechanistic insights into mineral carbonation. Geosciences, (2018), 8(7), 260.

Reactor Design: conventional vs. intensified/integrated





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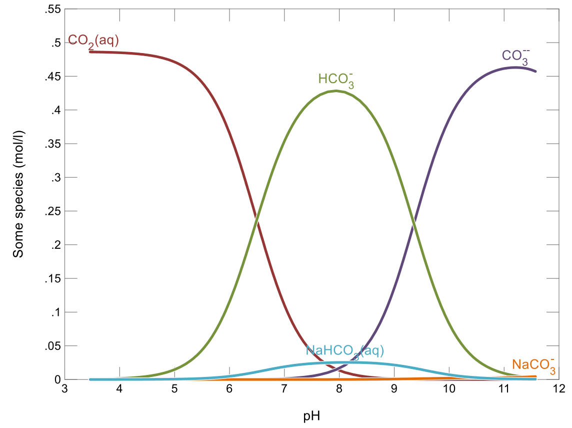
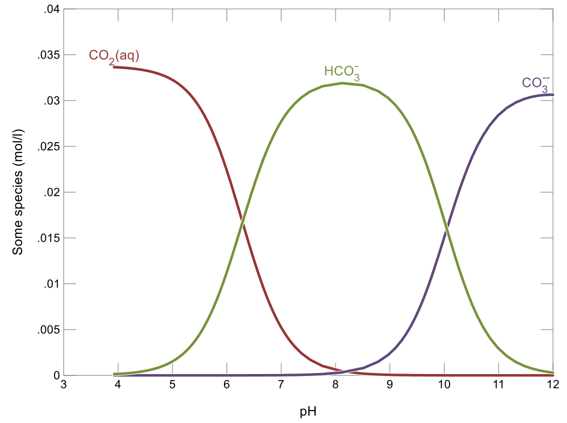
Integrated Mineral Carbonation Reactor Technology for Sustainable Carbon Dioxide Sequestration: 'CO$_2$ Energy Reactor'. [Energy Procedia, (2013), 37, 5884-5891].

CO$_2$ Energy Reactor – Integrated Mineral Carbonation: Perspectives on Lab-Scale Investigation and Products Valorization. [Frontiers in Energy Research, (2016), 4, 5].

Geochemical Modeling: P & T effects



T = 150°C, P = 60 bar CO_2, 0.64 M NaCl



T = 25°C, P = 1 bar CO_2

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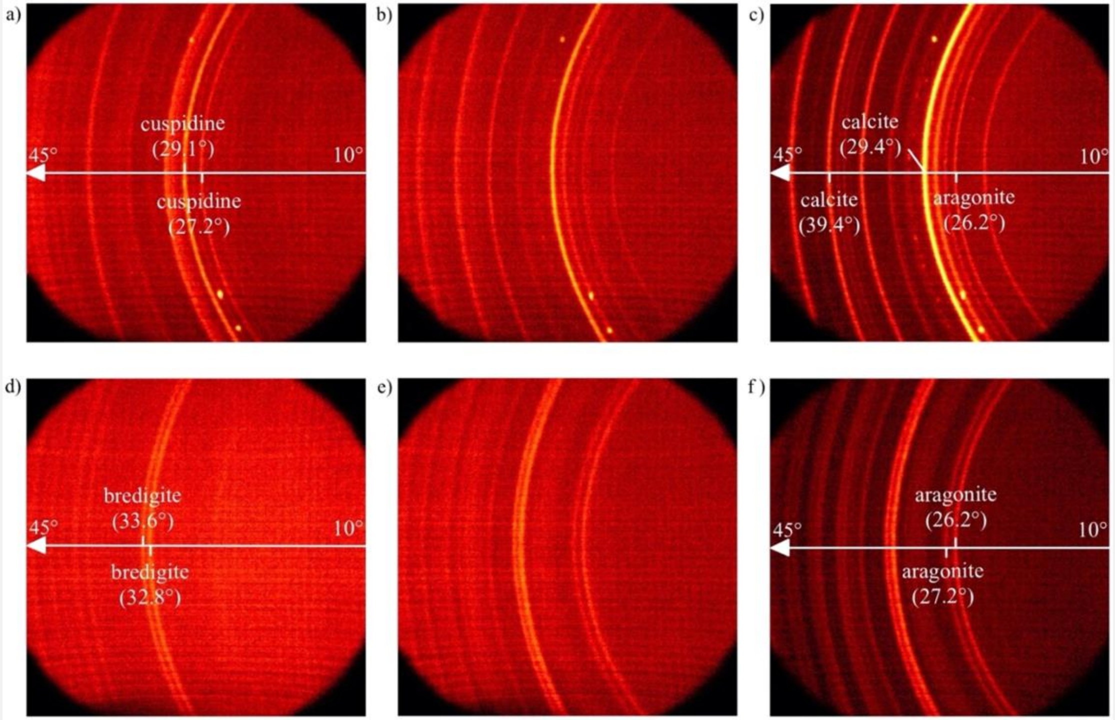
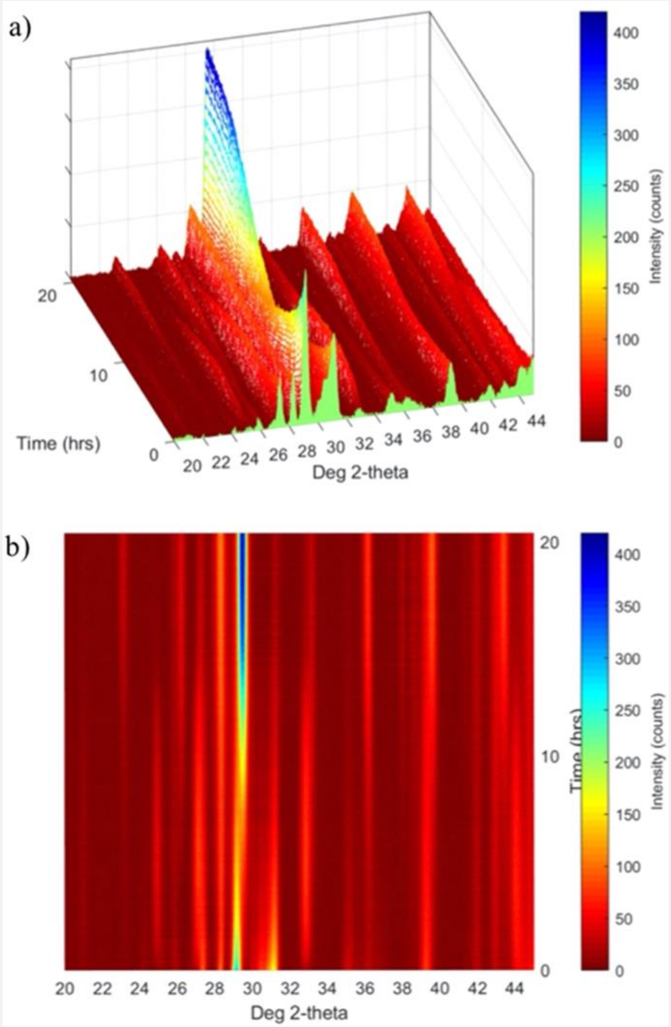
In-situ Investigation





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Pressurized in situ x-ray diffraction insights into super/subcritical carbonation reaction pathways of steelmaking slags and constituent silicate minerals, [The Journal of Supercritical Fluids, (2021), 171, 105191].

Thank You.

Questions?

santosr@uoguelph.ca

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